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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/522,832	03/10/2000	Katsuhisa Sawazaki	PMS 257760	4821

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EXAMINER

BAUMEISTER, BRADLEY W

ART UNIT	PAPER NUMBER
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2815

DATE MAILED: 09/19/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.
09/522,832

Applicant(s)
Sawazaki et al.

Examiner
B. William Baumeister

Art Unit
2815



-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on Sep 4, 2002
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1 and 4-7 is/are pending in the application.
- 4a) Of the above, claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1 and 4-7 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
*See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s). 15 6) ☐ Other:

Art Unit: 2815

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless -

(e) the invention was described in-

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

2. Claims 1 and 4-6 are rejected under 35 U.S.C. 102(e) as being anticipated by Nakamura et al. '307 for the reasons set forth in the previous Office Actions.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Art Unit: 2815

4. Claim 7 is rejected under 35 U.S.C. 102(e) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Nakamura '307 as applied to the claims above. Newly added claim 7 further recites that both the clad and the barrier are specifically composed of GaN.

a. Nakamura expressly states that the barrier layers of the MQB active region 16 may be composed of GaN (col. 6, line 29). While Nakamura states that it is *preferable* that layer 201 is formed of an aluminum-containing nitride (AlGaN) (col. 10), the disclosure is not so limited. Rather, the reference also expressly states that the tunnel/barrier "layer 201 ... is formed of a nitride semiconductor layer having a band gap energy larger than that of the active layer 16 (more strictly, its well layer)" (col. 10, lines 10-); and it expressly states that layer 201 "has a band gap energy which is larger than that of the active layer by 0.01 - 4.05 eV" (e.g., col. 4, lines 20-21). Further, the bandgap difference between the GaN-based active layer's barriers and wells would necessarily be greater than 0.01 eV; otherwise the active region would not be a superlattice, but would instead be a bulk semiconductor region. Restated, Nakamura's teaching that the tunnel/barrier layer 201 can have a bandgap that is anywhere from 0.01 to 4.05 eV greater than that of the well (which, in turn, is less than that of either the effective or barrier layers' bandgaps), is a teaching that the tunnel/barrier can have a band-gap energy that is either less than, the same as, or greater than that of the active layer's GaN barrier. Moreover, this teaching that the bandgap of the tunnel/barrier may be the same as that of the active region's barriers, is merely another way of saying that the two layers are composed of the same material; e.g., GaN.

Art Unit: 2815

b. Accordingly, since Nakamura teaches that active layer barrier may be GaN and the tunnel/barrier may be made of any bandgap(/composition) within a range that includes GaN, Nakamura anticipates the claim.

c. Alternatively, assuming arguendo that Nakamura must be interpreted so narrowly such that the disclosure of the range is not a disclosure (that the tunnel/barrier may also be composed of GaN) of sufficient particularity as to constitute a data point that would serve as the basis for a 102 anticipation rejection, the claim would nonetheless be obvious over Nakamura. This is because changing the bandgap(/composition) of the tunnel/barrier does not produce any unexpected results. Rather, such changes produce well understood and expected results: as the bandgap increases (as more Al is added to GaN), the tunnel/barrier becomes progressively more efficient in preventing carrier overflow, and the injection efficiency decreases somewhat relative to if no tunnel/barrier was present (because the tunneling probability is necessarily less than 1 and increasing the tunnel/barrier bandgap increases the proportion of carriers that are injected by tunneling). Conversely, as the bandgap decreases, (as the Al is decreased or as more In is added to GaN), the injection efficiency increases, but the tunnel/barrier becomes progressively less efficient in preventing carrier overflow from the opposite side of the active region. Also, increasing the thickness of a tunnel/barrier of any given bandgap decreases the tunneling probability.

d. Accordingly, since Nakamura teaches that active layer barrier may be GaN and the tunnel/barrier may be made of any bandgap/composition within a range that includes GaN, it

Art Unit: 2815

would have been obvious to one of ordinary skill in the art at the time of the invention to make both the active region's barriers and the tunnel/barrier of GaN because this particular combination is within the range of possibilities disclosed by Nakamura, and one of ordinary skill would have been motivated to choose this particular combination depending only upon conventional and well understood considerations such as the desired light-emission wavelength of the MQB and the desired balance of the tradeoff between injection efficiency and carrier overflow of the particular application; or for various other reasons such as (1) because binary compounds (i.e., GaN) are more stable and easier to form than tertiary compounds (e.g., AlGa_N or InGa_N); or (2) for considerations of better lattice-matching of the tunnel/barrier to the adjacent MQB barrier since GaN has a lattice constant that is closer to the InGa_N compositions than does any of the AlGa_N compositions.

Response to Arguments

5. Applicant's arguments filed 7/8/02 and 9/4/02 have been fully considered but they are not persuasive for the reasons set forth previously, hereinabove and hereinbelow.

a. Applicant has argued that the exemplary MQW presented during the course of the interview was inaccurate as it oversimplified the calculations of the MQW's effective bandgap. Initially, it is unclear how such an oversimplification is related to the basis of the rejection. More importantly though, the examiner notes that the bandgap diagrams and examples provided during the interview are not part of the record and did not serve as a part of the basis of the rejections.

Art Unit: 2815

The rejections are based on the Nakamura reference and the explanations thereof as set forth and made of record in the Office Actions.

b. However, since Applicant has raised the issue on the record, the Examiner feels compelled to address this argument to correct the record: the sole purpose of the examples provided to Applicant's representatives during the interview was merely to help Applicant's representatives obtain a cursory, *qualitative* understanding of (1) how changing the In and Al concentration of GaN-based materials influences a composition's bandgap; and (2) how superlattices can be employed to influence the effective bandgap of the active region. Further, while the Examiner does not remember the precise compositions employed in the examples discussed at the interview, nor the specific, arbitrary energy levels attributed thereto, the Examiner does remember (1) that the interview was conducted in the office of the Examiner's supervisor, so the examiner did not have quantitative data available for the bandgaps of GaN-based materials; (2) that the examiner explained to the representatives that the numbers used were chosen arbitrarily, merely to provide a general, relative relationship; and (3) that the effective bandgap of the MQB would be somewhere in between that of the barrier and the well, but that the actual, specific, effective bandgap depended upon various factors such as, but not limited to, the well's depth and width. Accordingly, the examiner fully agrees that merely taking an arithmetic average of the barriers' and wells' bandgaps would be an overly simplistic and insufficient way to calculate the effective bandgap. However, this was never the Examiner's position nor basis of the rejections, so the argument is moot.

Art Unit: 2815

c. Applicant has further argued that making the tunnel/barrier composition the same as that of the barrier would be detrimental to the effect of blocking carrier overflow, which is the goal of Nakamura, and therefore, Nakamura does not teach that this relationship is disclosed. This argument is not convincing because while Nakamura is directed towards blocking carrier overflow, and further states that this is *preferably* accomplished by forming the tunnel/barrier of AlGaN, these facts do not detract from the additional fact that Nakamura also expressly teaches that preventing carrier overflow may be also accomplished by providing GaN-based tunnel/barriers that have any bandgap that is 0.1 eV or greater than that of the active layer's well (as opposed to either one of the higher barrier or effective bandgaps). Accordingly, the rejections are still deemed to be proper and therefore maintained.

Conclusion

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR

Art Unit: 2815

1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.


INFORMATION ON HOW TO CONTACT THE USPTO

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister**, at (703) 306-9165. The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Eddie Lee, can be reached at (703) 308-1690. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

B. William Baumeister

Patent Examiner, Art Unit 2815

September 18, 2002



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SUPERVISORY PATENT EXAMINER
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